Proton production spectrum at Ultra High Energy (UHE): multi Pomeron exchanges and growing cross sections, triple Pomeron contribution and UHE spectra of cosmic neutrinos, four Pomeron toroid term and Baryonium Dark Matter

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Outline

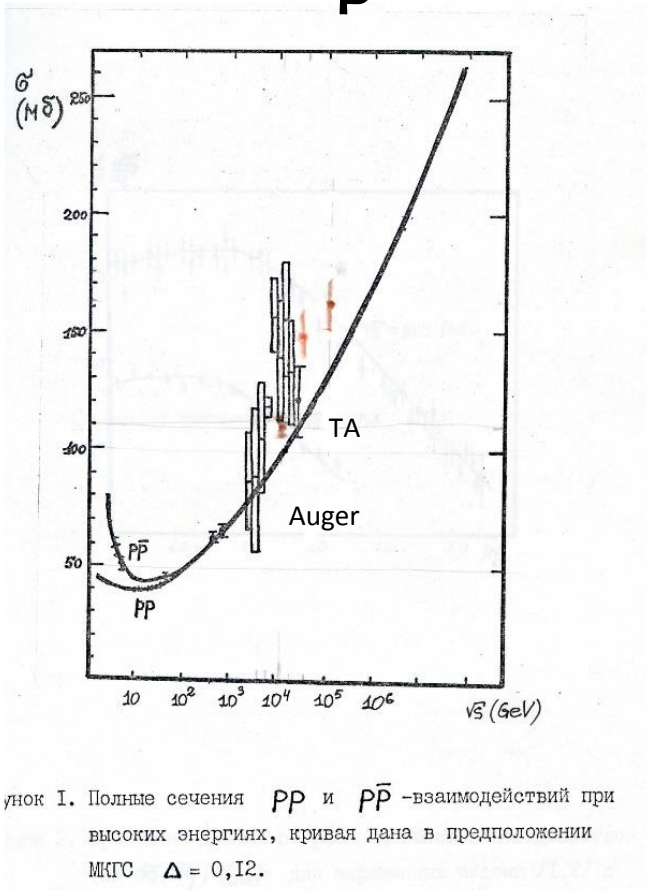
I. Supercritical Pomeron and growing cross sections of multi particle production (intro to Pomeron exchanges and details of proton spectra at HE collider experiments)

II. Enhanced terms in Topological Expansion diagrams (triple Pomeron contribution and proton production spectra in diffractive region)

III. Four Pomeron exchange as an evidence of neutral Baryonium Dark Matter states

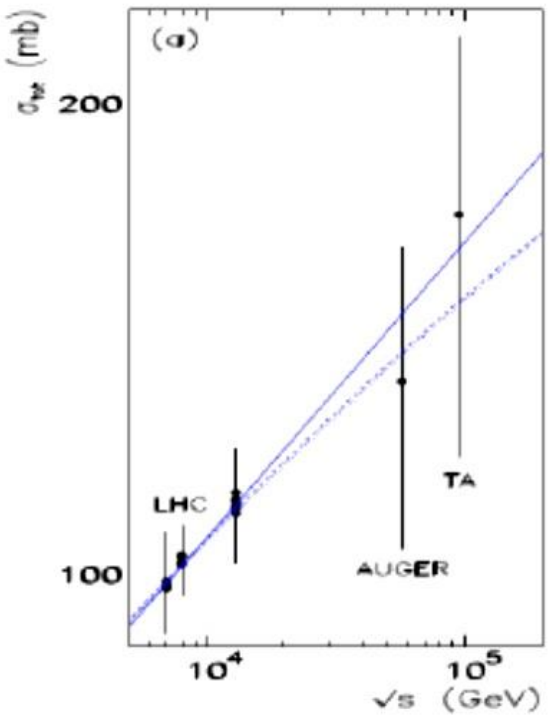
I.1 Introduction to Pomeron exchanges and production cross sections growing with energy

$$\sigma \sim s^{\alpha_P(0)-1}$$



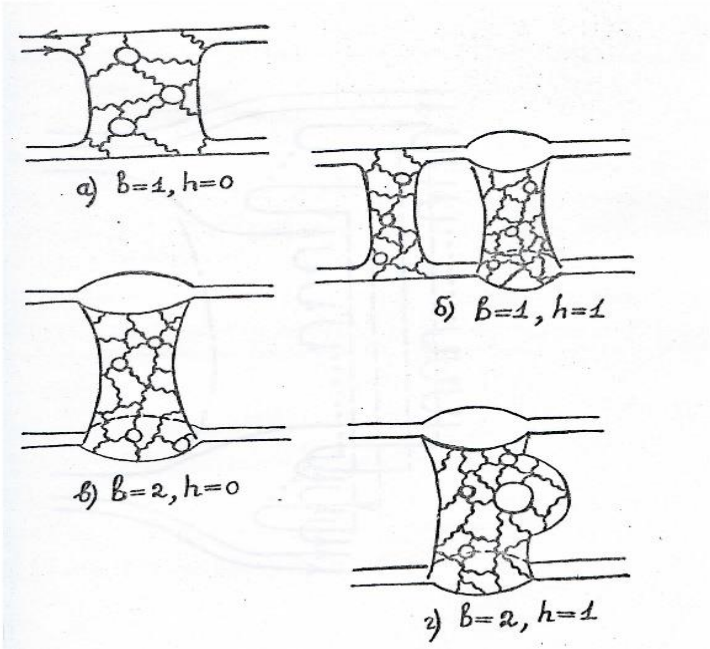
унок I. Полные сечения PP и $P\bar{P}$ -взаимодействий при высоких энергиях, кривая дана в предположении МКГС $\Delta = 0,12$.

E.L.Feinberg and I.Pomeranchuk, Suppl.Nuovo Cimento 4 (1956)652



arXiv.org:2012.08664

I.2 Multi Pomeron Exchanges and spectra of baryon production at HE collider experiments



нок 5. Различные конфигурации диаграмм КХД в первых порядках топологического разложения.

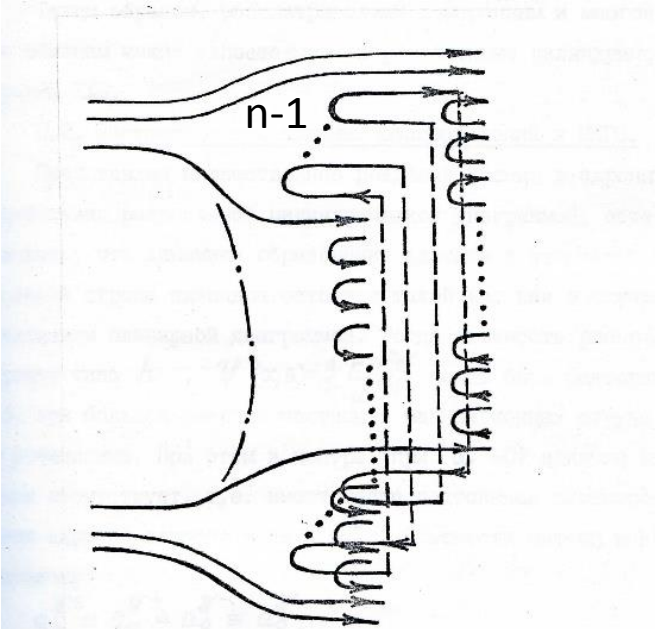


Рисунок 6. Разрезанная цилиндрическая диаграмма.

I.3 Specifics of leading fragmentation in Quark Gluon String Model for baryon production

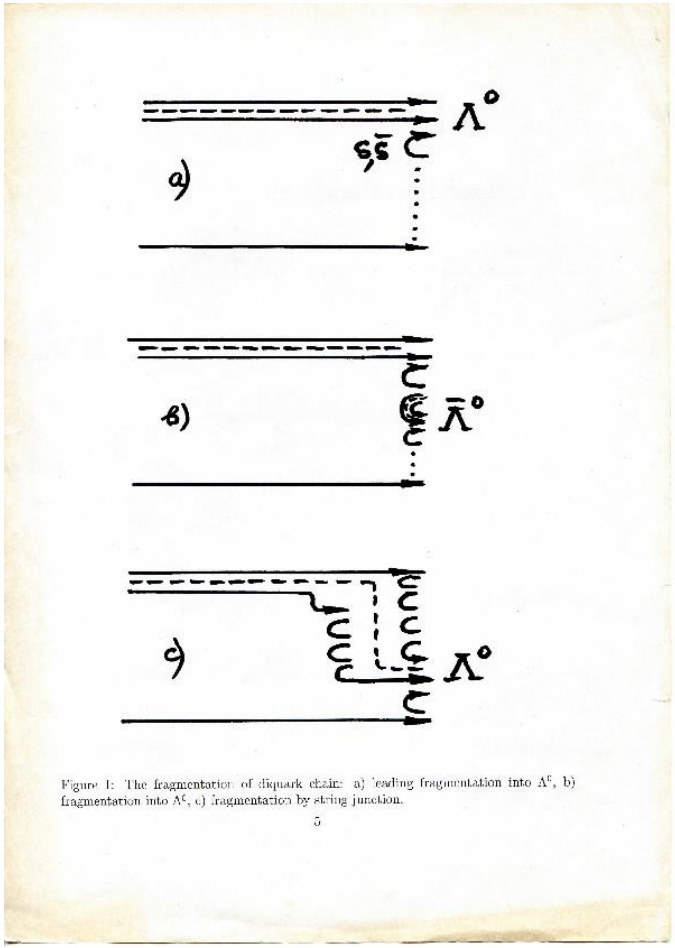


Figure 1: The fragmentation of diquark chain: a) leading fragmentation into Λ^0, b) fragmentation into $\bar{\Lambda}^0$, c) fragmentation by string junction.

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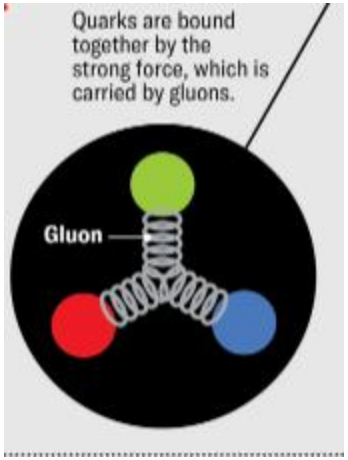
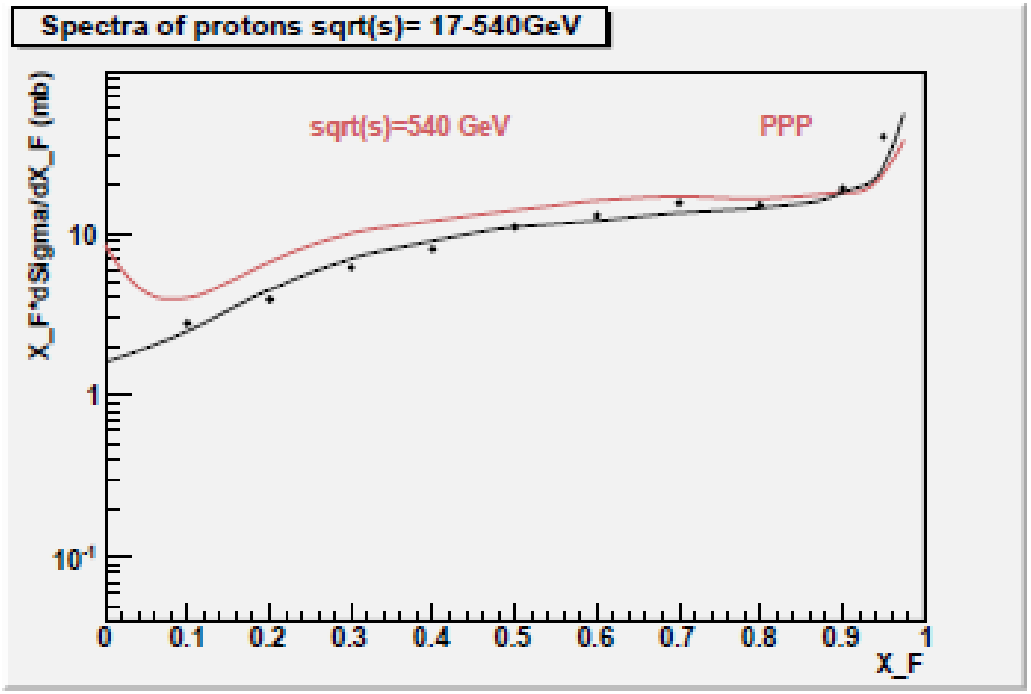


In the case of baryon production, the string junction (SJ) of projectile baryon plays the important role: it brings extra baryon charge in central fragmentation region.

II.1 Triple Pomeron exchange as enhanced diagram of Topological expansion and diffractive peak in HE proton production spectrum



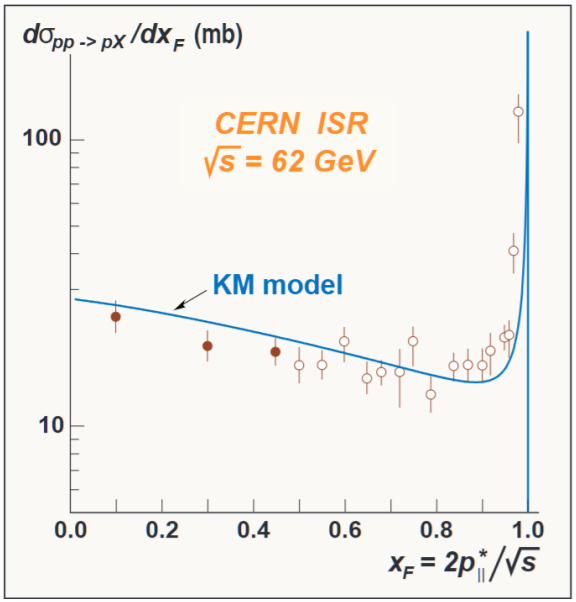
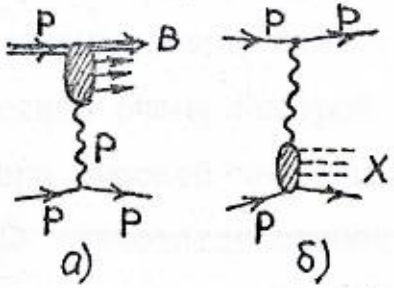
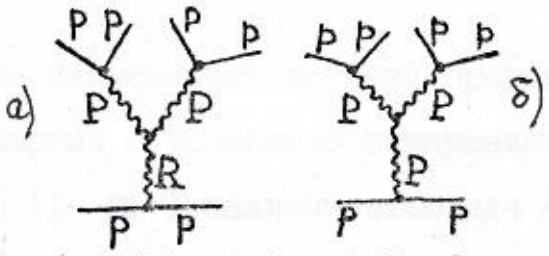


Figure 1: QGSM production spectra of protons in p-p collisions at colliders: the prediction for proton spectrum at the energy 540 GeV are shown with red line, QGSM proton distribution at lower energy, $p_L = 175 GeV/c$ is shown with solid line.

PPP contribution to proton spectrum



I7. Основная а) и дополнительная б) диаграммы при образовании лидирующего протона в PP-взаимодействии.



I8. Трехреджеонная диаграмма, соответствующая вкладу Рис.I7 б) в инклюзивное сечение в пределе $x \to 1$.

II.3 Proton spectra in laboratory system at the energy Elab ~ 10^12 GeV

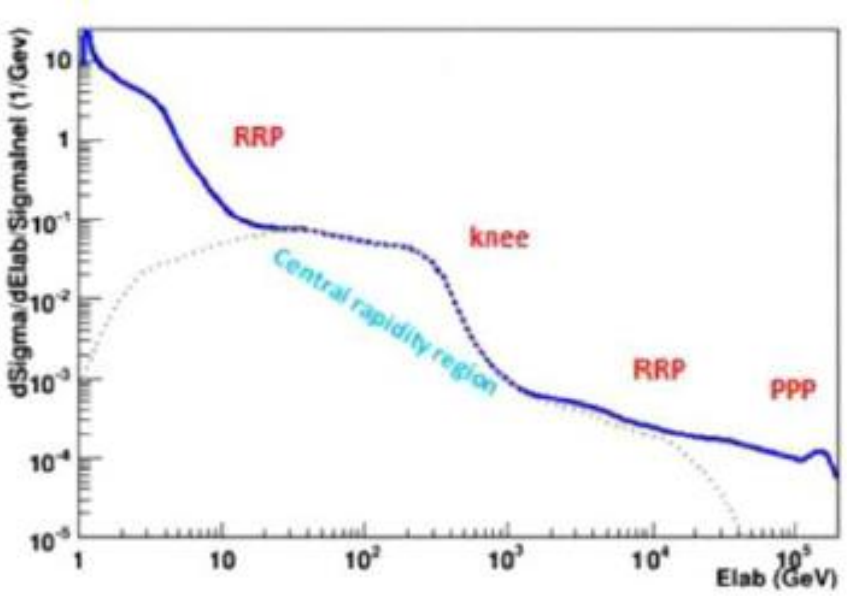
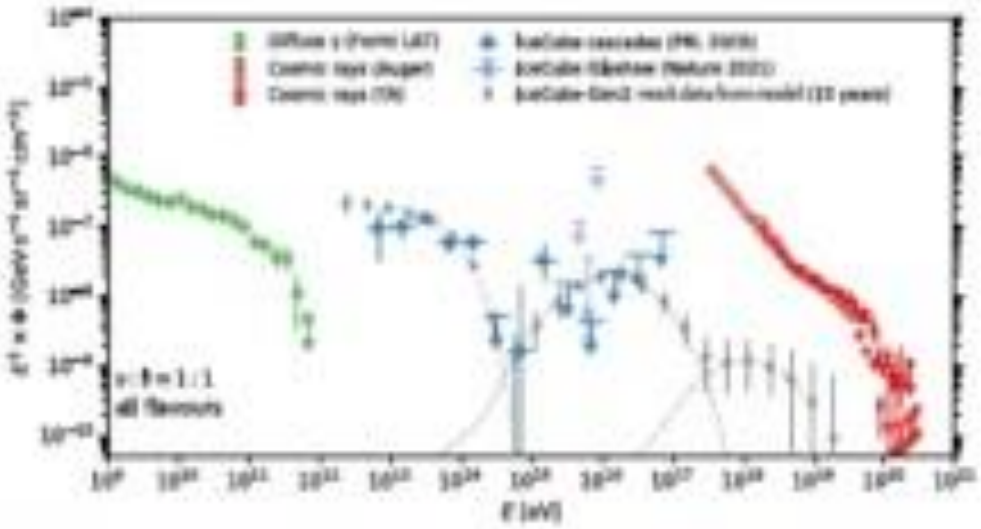


Figure 3: The form of proton spectra after UHE p-p collision in laboratory system, the antiproton spectrum is shown with dashed line.

The energy of knee in cosmic spectra show the position of center of rapidities in c..m. system. The maximal energy of spectrum can be calculated from the equation $y_{max}=2*y_{c.m.s.}$

The peak at the end of proton spectrum has been drawn approximately, because collider experiments can not measure the end of spectrum so close to x=1, see arXiv.org: 2211.07649

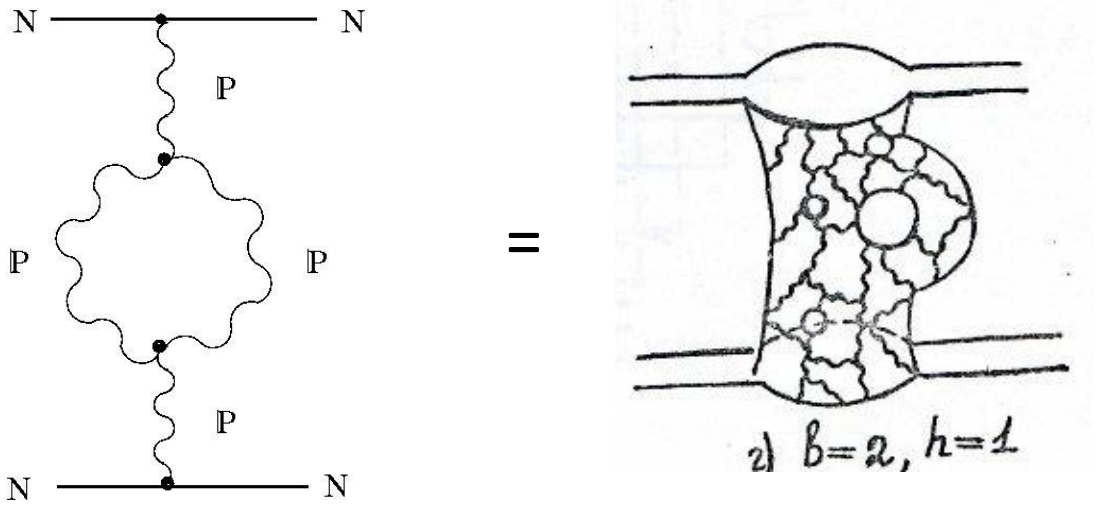
II.2 The bump at the end of UHE spectra of protons, neutrinos and gammas in Cosmic Rays



S.Musio, G.R. Farrar and M. Unger
arXiv.org:2108.05512

Figure 5.15: A fiducial model for the flux of neutrinos which illustrates the qualitative range of reasonable possibilities. This model consists of three components: 1) a UHECR-produced peak at 10^{18} eV giving the best-fit to the high-energy astrophysical neutrino flux consistent with UHECR data from Auger and IceCube, taken from [352]; 2) a peak at 10^{18} eV due to GZK-produced neutrinos assuming a 10% proton fraction above 30 EeV, taken from [369]; and 3) a low-energy component of neutrinos produced by some non-UHECR sources, tuned to give the best-fit to the low-energy astrophysical neutrino data. The shown points for IceCube-Gen2 are mock data for this model for 10 years of combined optical and radio measurements. A number of other plausible models for the astrophysical neutrino flux based on specific astrophysical source types are explored e.g., in Refs. [425, 461, 462, 253].

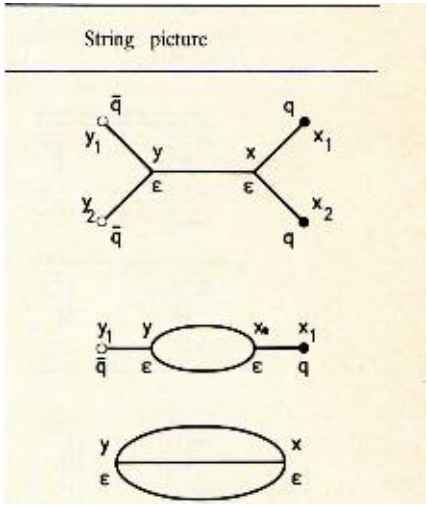
III.1 Four Pomeron exchange at LHC and heavy neutral baryonium



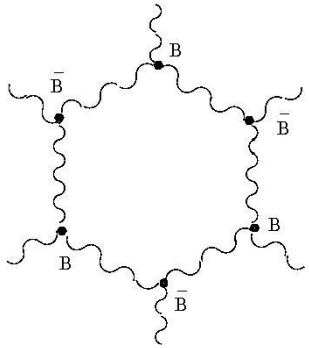
This exchange corresponds to the following multi particle production: inelastic double diffraction, and doubled multiplicity production at the central rapidities,

It has probability ~ 4% to be detected at pp collisions.

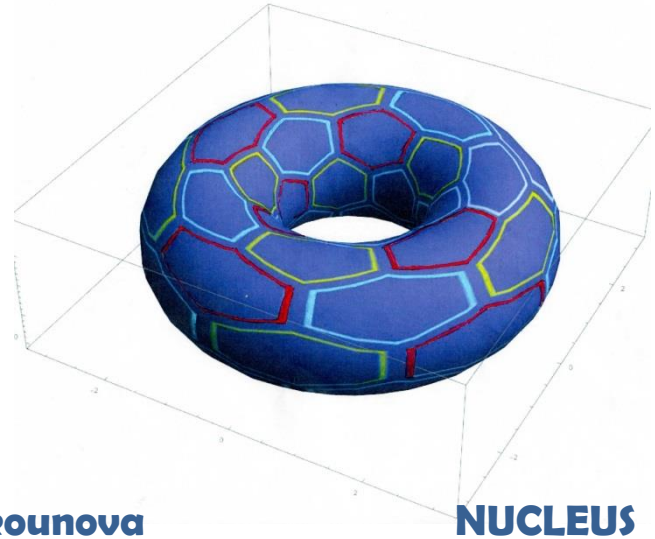
III.2 Quarkless baryonium and the way to build Baryonium Dark Matter particles



Two string junctions can be connected with no quarks outside and no open colors

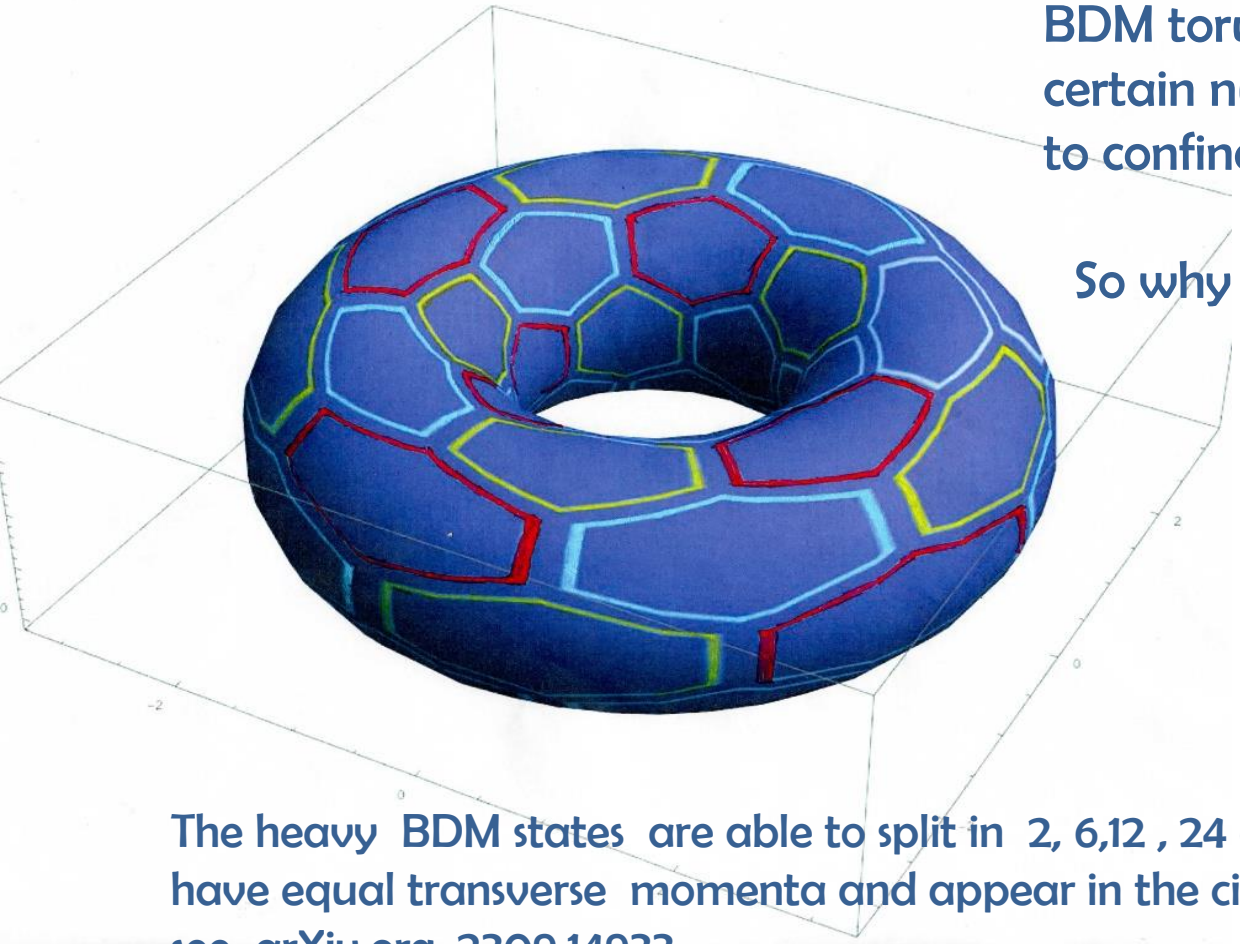


The hexagons of 3 baryon string junction and 3 antibaryon string junction can build closed net on the surface of torus



The Baryonium Dark Matter particle can be constructed with 6,12,24,48,96.... gluon hexagons so why they have discrete masses

More features of BDM



BDM torus have to consist of the certain number of hexagons in order to confine colors: 6,12,24,48 etc.

So why its masses are discrete values

The heavy BDM states are able to split in 2, 6,12 , 24 etc. of similar BDMs that have equal transverse momenta and appear in the circles in the sky, see arXiv.org: 2309.14933.

Spoiler: torus has one wormhole and two singularities.

Conclusions

Pomeron is inexhaustible as an electron. The study continues almost 70 years. Now it reinforces the theme of QCD matter in the modern astrophysics.

I.1 Multi pomeron exchanges support the growth of hadroproduction cross sections and give the unique possibility to predict the inclusive spectra of hadrons at Ultra High Energies (UHE) with one parameter: pomeron trajectory intercept.

II.1 The triple-pomeron diffraction process makes the signature in the UHE spectra of protons, neutrinos and gammas. The similar bumps at highest energy shows that these particles in space are the products of UHE interaction of proton, which was ejected from Supermassive Black Hole with so high energy that can be compared with Plank mass (10^19 GeV).

III.1 "Compactificated" Pomeron, the fourth order of Topological Expansion, represents Baryonium Dark Matter (BDM) state. It may be that these heavy and neutral extremal states of the pomeron strings play an important role in the evolution of Universe, because they have to show itself a) in the absorption of baryonic matter with Supermassive Black Hole without the break of information memory, b) as the energy reserve that is refueling the propagation of jets from SMBH, and c) as the means of transporting matter to the periphery of Universe for the formation of new galaxies.